CONSTRUCTIONS WITH LEXICAL INTEGRITY: TEMPLATES AS THE LEXICON–SYNTAX INTERFACE

Ash Asudeh	Mary Dalrymple	Ida Toivonen
Carleton University	University of Oxford	Carleton University

Proceedings of the LFG08 Conference

Miriam Butt and Tracy Holloway King (Editors)

2008

CSLI Publications

http://csli-publications.stanford.edu/

Abstract

LFG differs from Construction Grammar (CG) in assuming a strict separation between the lexicon and the syntax. The LFG architecture and the principle of Lexical Integrity dictate that fully inflected words are 'inserted' one by one into the c-structure, which does not seem to permit the blurring of the boundary between words and larger syntactic units that CG advocates. This paper addresses the question of how the intuitions behind constructions (in the CG sense) can be formalized within LFG, without rejection of the foundational assumptions behind the LFG framework. The key insight in our approach is the use of LFG templates (Dalrymple et al. 2004, Crouch et al. 2008) to factor out grammatical information in such a way that it can be invoked either by lexical items or by specific c-structure rules. C-structure rules that invoke specific templates are thus the equivalent of constructions in our approach, but Lexical Integrity and the separation of lexicon and syntax are preserved.

1 Introduction

The principle of Lexical Integrity is central to LFG. It can be formulated as follows:

(1) **Lexical Integrity**
The terminal nodes of c-structures are morphologically complete words.

This clearly has consequences for word formation, but it also has consequences for the analysis of so-called 'constructions', by which we mean multi-word expressions that are not analyzed compositionally. The lexicon provides c-structure with (fully inflected) individual words, not multi-word phrasal expressions.

Idioms may appear to pose a problem for Lexical Integrity, but these can often be accounted for by having one lexical item explicitly 'call for' another word when it is associated with a specific meaning. An example is provided by Kaplan and Bresnan's (1982) analysis of the idiom *keep tabs on*. They posit the following lexical entry (Kaplan and Bresnan 1982:67):

(2) *kept* V $(\uparrow \text{TENSE}) = \text{PAST}$
$(\uparrow \text{PRED}) = \text{`observe}\langle(\uparrow \text{SUBJ})(\uparrow \text{ON OBJ})\rangle\text{'}$
$(\uparrow \text{ON OBJ FORM}) =_c \text{TABS}$

However, in the Construction Grammar (CG) framework, it has long been argued that constructions are more general than idioms (Fillmore 1988, Goldberg 1995, Kay and Fillmore 1999). According to that literature, there are multi-word expressions that are less frozen in form than prototypical idioms, but that nevertheless correspond non-compositionally to a specific meaning. Crucially, it is claimed that the syntactic frame of the multi-word expression itself corresponds to some meaning; that is, the syntactic frame itself, perhaps along with some specifications on what words are permitted, invokes an interpretation. Expressions such as (3–5) have been used to argue for this construction grammatical point:

(3) The more the merrier; the bigger the better, etc. (Fillmore et al. 1988, Culicover and Jackendoff 1999)

(4) What's that koala doing sleeping in the corner? (the 'What's X doing Y' construction: Kay and Fillmore 1999)

(5) Smithy drank his way through university. (Jackendoff 1990, Goldberg 1995)

Most words in the expressions above are exchangeable for other words, so they seem more flexible than prototypical idioms. Yet their form and associated interpretation must be learned by English speakers, as these constructions do not, it is argued, follow from general compositional principles of English grammar. CG posits that all combinatorial morpho-syntactic units (morphemes, words, phrases) are constructions, where these units can be specified to a greater or lesser extent for form and meaning.

[†]We thank the audience at LFG08, in particular Kersti Börjars, Dag Haug, Helge Lødrup, Marie-Elaine van Egmond, and Nigel Vincent, for helpful discussion and comments.

Expressions such as the ones in (3–5) instantiate relatively specific phrasal multi-word constructions, as opposed to, e.g., the general intransitive construction, which is not very detailed in its specifications.

This paper addresses the question of how the intuitions behind constructions (in the CG sense) can be formalized within LFG without rejection of the foundational assumptions behind the LFG framework. Unlike CG, we will not adopt the position that all grammatical entities (phrases, words, morphemes) are constructions. Instead, we consider how to incorporate into LFG specific types of phrasal constructions for which it has been argued that part of the interpretation does not seem to be directly contributed by any of the individual words. The paper will specifically deal with the English *way*-construction and a related construction in Swedish, the *Directed Motion Construction*.[1]

The key insight in our approach is the use of LFG templates (Dalrymple et al. 2004, Crouch et al. 2008) to factor out grammatical information in such a way that it can be invoked either by lexical items or by construction-specific c-structure rules. C-structure rules that invoke specific templates are thus the equivalent of constructions in our approach, but Lexical Integrity and the separation of lexicon and syntax are preserved. However, there is a potentially deep consequence for the theory of the lexicon, because verbs in our approach specify default subcategorization through template calls in such a way that the subcategorization can be constructionally overridden. Thus, subcategorization is moved to the template component, which in our system is the interface between the lexicon and syntax.

2 Case study: Traversal constructions

2.1 English

It has been argued that the English *way*-construction in (6) deserves a constructional analysis rather than a compositional one, since the construction implies directed motion even though none of the individual words in *way*-examples necessarily denotes motion (Jackendoff 1990, Goldberg 1995). The action denoted by the verb *elbow* does not normally involve traversal, though in example (6) this meaning is present.

(6) Sarah elbowed her way through the crowd.

In such cases, some properties of the construction – either the phrasal configuration, some combination of words in the construction, or both – are responsible for its meaning.

Since the various manifestations of the English construction have in common the word *way*, our analysis attributes the special syntactic and semantic properties of the construction to the presence of this word. Specifically, we propose that the lexical entry for the word *way* is associated with a particular template which overrides the default subcategorization requirements and semantics of the verb in the construction, replacing them with the syntax and semantics of the *way*-construction. Thus, our treatment of the English *way*-construction involves lexical specification of the properties of the word *way*. Crucially, however, the same specifications can be associated with a phrase structure rule rather than a word, as we will see in our analysis of the Swedish Directed Motion Construction, a construction with similar meaning to the *way*-construction but with idiosyncratic phrase structure properties.

In fact, for most English speakers the English *way*-construction has two closely related meanings, one involving means and one involving manner (Jackendoff 1990:215, Goldberg 1995:202–212), though Goldberg (1995:202–203) points out that the manner interpretation is not available for all speakers. Examples (7) and (8) both involve an event denoted by the main verb (whistling or elbowing) and its relation to a second event of traversal of a path. The verb *elbowed* in example (7) specifies the means by which Sarah managed to traverse the crowd: the traversal was made possible by the elbowing action. For those who allow the manner interpretation, the verb *whistled* in example (8) specifies the manner in which the traversal of the room took place: Sarah whistled while crossing the room.

[1]This paper does not treat periphrastic morphology or complex verbs, which are also examples of expression larger than single words that one might want to store in the lexicon. For discussions of periphrasis in LFG, see Sadler and Spencer (2004) and for LFG analyses of complex verbs, see Alsina (1993) and Butt (1995).

(7) Means: Sarah elbowed her way through the crowd. (traversed the crowd by means of elbowing)

(8) Manner: Sarah whistled her way across the room. (traversed the room while whistling)

The use of templates in our analysis allows us to specify what these meanings have in common and how they differ, as well as allowing the statement of cross-linguistic similarities and differences in similar constructions in other languages.

Jackendoff (1990:216) and others have claimed that the possessor in the English *way*-construction must be coreferential with the subject, and indeed, in an overwhelming number of cases, this generalization holds. However, we have found examples which counterexemplify this claim:

(9) He had bought his son's way into an exclusive military academy normally reserved for the gentry and had outfitted him in style. (www.samizdat.com/hero7.html)

(10) As ambassador, Chesterfield negotiated Britain's way into the Treaty of Vienna in 1731. (www.aim25.ac.uk/cgi-bin/frames/fulldesc?coll_id=2117&inst_id=86)

Furthermore, the noun *way* in the *way*-construction can be modified (Jackendoff 1990:217, Goldberg 1995:206):

(11) In these last twenty years Richard Strauss has flamed his meteoric way into our ken — and out of it. (Buchanan 1918)

Our analysis of the construction must be able to derive a meaning for these examples as well.

2.2 Swedish

Toivonen (2002) discusses the Swedish Directed Motion Construction, exemplified in (12).

(12) Sarah armbågade sig genom mängden.
S. elbowed SELF through crowd.DEF
∼ 'Sarah elbowed her way through the crowd.'

The Swedish DMC is very similar in meaning and use to the English *way*-construction, but the DMC does not include any word such as *way* to flag the construction. Instead, the construction is distinguished by the strict requirement for the presence of certain constituents, restrictions on the individual constituents, and perhaps most interestingly, by a word order quirk at odds with the rest of Swedish grammar (Toivonen 2002). Consider (13a–b):

(13) a. Jonas knuffade sig in i mängden.
J. pushed SELF in inside crowd.DEF
'Jonas pushed his way into the crowd.'

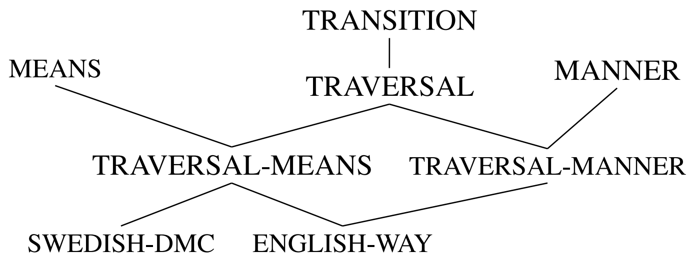
b. Jonas knuffade in dig i mängden.
J. pushed in you inside crowd.DEF
'Jonas pushed you into the crowd.'

Verbal particles (such as *in*) are normally required to precede the direct object in Swedish, as in (13b). However, in the DMC, the particle follows *sig*, as in (13a). Toivonen's (2002) analysis makes use of a lexical redundancy rule which alters the verb's lexically specified argument structure and semantics, relating a 'regular' verb, e.g. *knuffa* 'push', to a DMC version of that verb. We propose a different analysis here: the special configurational properties of the example are accounted for by a special phrase structure rule which is associated with a template like the one proposed for the analysis of the English *way*-construction. The English and Swedish constructions have a number of syntactic and semantic attributes in common, which are captured by very general templates in the template hierarchy; differences between the two constructions are captured by associating them with different specific templates in the hierarchy, as we now describe.

3 Encapsulating generalizations: Transition Template Hierarchy

We propose a single theory of constructions that uses existing LFG mechanisms to capture commonalities between the English *way*-construction and the Swedish DMC. Our theory preserves the intuition that the *way*-construction is driven by lexical specifications for *way* together with general phrase structural facts about English, as well as the intuition that the DMC is driven by a specific phrase-structural configuration. The template hierarchy we assume is represented in (14):

(14)



This diagram represents the relations among the templates: information from templates high in the hierarchy is passed down via the lines connecting the templates, so that the templates at the bottom of the hierarchy include all of the information from higher templates that they are directly or indirectly connected to. In (14), the template TRAVERSAL contains material that is common to the Swedish DMC and the English *way*-construction. Templates are just packages of grammatical information, and can be defined in terms of other templates. The TRAVERSAL template is defined in terms of the more general TRANSITION template, as represented by the line connecting them, which means that TRAVERSAL incorporates all of the information associated with the TRANSITION template while also contributing some information specific to TRAVERSAL. TRAVERSAL in turn appears as a part of the definition of both the TRAVERSAL-MEANS template and the TRAVERSAL-MANNER template.

The templates TRAVERSAL-MEANS and TRAVERSAL-MANNER provide different ways of adding information to the TRAVERSAL template, supplying the information that the main verb denotes either the means or the manner in which the path traversal is achieved. The Swedish DMC has the means interpretation (Toivonen 2002:318), and so we treat it as associated with the TRAVERSAL-MEANS template; the manner interpretation may be available dialectally, but we do not treat this variation here. Finally, the templates SWEDISH-DMC and ENGLISH-WAY contribute additional language-specific information to these templates, as we will see.

4 Formal Analysis

4.1 Phrase structurally flagged constructions

4.1.1 The phrase structure rule

Turning first to the Swedish DMC, we propose that this construction is most elegantly analyzed with the following construction-specific phrase structure rule, which makes crucial use of a call to the template SWEDISH-DMC:

(15)
$$\begin{array}{cccc} \mathrm{V}' & \rightarrow & (\mathrm{V}^0) & \mathrm{NP} & \mathrm{PP} \\ & & \uparrow = \downarrow & (\uparrow \textsc{obj}) = \downarrow & (\uparrow \textsc{obl}) = \downarrow \\ & & & (\downarrow \textsc{prontype}) = \textsc{simplex-reflexive} & \\ & & & @\text{SWEDISH-DMC}((\uparrow \textsc{pred fn})) & \end{array}$$

The template call appears on the NP node. By convention, template calls are marked by the at sign '@'. The SWEDISH-DMC template takes a single argument, the value of the PRED FN of the V′; we provide more information about this template in 4.1.2.

We observe four important properties of our treatment of the SWEDISH-DMC. First, associating the template for this construction with a special phrase structure rule reflects the fact that only this particular configuration has the special meaning associated with the DMC.

Second, the NP and PP daughters of V$'$ in (15) are obligatory. Our theory assumes that optionality must be explicitly marked in phrase structure rules, as in computational LFG treatments (e.g. Crouch et al. 2008) and in contrast to theoretical positions that allow generalized optionality (e.g. Bresnan 2001). The V^0 node is optional, since the verb need not appear there: the Swedish finite verb appears in I rather than V.

Third, we must explicitly state the fact that the NP is a simplex reflexive, such as *sig*, and not just any kind of NP or even a complex reflexive (e.g. *sig själv*).

Fourth, the construction requires an OBL phrase, which must be realized as a post-object PP.

4.1.2 The SWEDISH-DMC template

Semantically, the Swedish DMC and the English *way*-construction involve an event characterised by the main verb in the construction and a second event involving traversal of a path. The basic template TRANSITION is defined as follows:

(16) TRANSITION $=$ $\lambda R \lambda x \lambda e \lambda e'.R(e) \wedge agent(e) = x \wedge cause(e') = x :$
$(\uparrow_\sigma \text{REL}) \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT1}) \multimap (\uparrow_\sigma \text{EVENT2}) \multimap \uparrow_\sigma$

Templates encoding syntactic information and expressing syntactic generalisations are defined as sets of functional equations, as described by Dalrymple et al. (2004). However, since our concern is the syntax-semantics interface and meaning differences among constructions, we define this template with a *meaning constructor* (Dalrymple 1999, 2001, Asudeh 2004), which provides part of the common meaning for the English *way*-construction and the Swedish DMC. This meaning constructor requires:

- a REL meaning R specifying the nature of the event e, which is provided by the verb in the construction; for *Bill elbowed his way through the crowd*, e is required to be an event of elbowing, and so R is the predicate *elbow*
- a meaning x for the subject of the main verb, which will be interpreted as the agent of e and as the causer of the transition event e'
- two event variables e and e', associated with the semantic attributes, EVENT1 and EVENT2, representing the event denoted by the verb and the transition event.

This basic meaning is augmented by other meaning constructors in the template hierarchy. Our characterisation of the subject of the main event as an agent of the event e and a causer of the transition event e' follows Goldberg (1995:212–213), who claims that the motion in the way-construction must be self-propelled. However, Jackendoff (1990:216) suggests that although the means interpretation is necessarily tied to deliberate action, the manner interpretation is also compatible with action that is not deliberately performed. Examples such as (17), which has a manner and not a means interpretation, indicate that the issue of whether the subject is always interpreted as an agent needs to be investigated further; in this example, e is an event of bleeding and does not seem to be associated with an agent:

(17) Baxter's wife said her son bled his way into the ambulance painlessly.
(http://newvoices.org/humor/the-slice-man-cometh.html)

We leave this issue for future research.

The template hierarchy in (14) encodes the fact that the template TRAVERSAL calls the template TRANSITION, with the effect that TRAVERSAL incorporates all of the information in TRANSITION as well as specifying some additional information. The TRAVERSAL template is defined in (18):

(18) TRAVERSAL $=$ @TRANSITION
$\lambda P \lambda e'.P(e') \wedge traversal(e') :$
$[(\uparrow_\sigma \text{EVENT2}) \multimap \uparrow_\sigma] \multimap [(\uparrow_\sigma \text{EVENT2}) \multimap \uparrow_\sigma]$

The first line in the definition of TRAVERSAL contains the call to the template TRANSITION, marked as in (15) with the at sign '@'. The second line adds the information that e' is a traversal event. In technical terms, this meaning constructor behaves as a modifier on the predication associated with the transition event.

In turn, the TRAVERSAL-MEANS template is defined simply by calls to the TRAVERSAL template and the MEANS template:

(19) TRAVERSAL-MEANS = @TRAVERSAL
@MEANS

The MEANS template is given in (20):

(20) MEANS $= \lambda P \lambda e \lambda e'.P(e)(e') \wedge means(e', e)$:
$$[(\uparrow_\sigma \text{EVENT1}) \multimap (\uparrow_\sigma \text{EVENT2}) \multimap \uparrow_\sigma] \multimap [(\uparrow_\sigma \text{EVENT1}) \multimap (\uparrow_\sigma \text{EVENT2}) \multimap \uparrow_\sigma]$$

The MEANS meaning constructor specifies that the event e represents the means of achieving the event e'. With respect to TRAVERSAL-MEANS, this means that the main verb's event e is the means of achieving the event e' of traversing the path, as in an English example like *Sarah elbowed her way through the crowd* or the Swedish equivalent, where the traversal through the crowd is achieved by elbowing.

The SWEDISH-DMC template, specific to the Swedish Directed Motion Construction, is defined by reference to the template TRAVERSAL-MEANS. It also calls the syntactic subcategorization template TRANSITIVE-OBLIQUE, to be described in Section 4.2, and provides some additional material specific to the Swedish construction:

(21) SWEDISH-DMC(FN) = @TRANSITIVE-OBLIQUE(FN)
@TRAVERSAL-MEANS
$$\begin{array}{l} \lambda Q \lambda P \lambda y.\exists e.\exists e'.\exists z.P(e)(e') \wedge \\ \quad theme(e') = y \wedge path(e') = z \wedge Q(z) : \\ [((\uparrow \text{OBL})_\sigma \text{ PATH}) \multimap (\uparrow \text{OBL})_\sigma] \multimap \\ \quad [(\uparrow_\sigma \text{EVENT1}) \multimap (\uparrow_\sigma \text{EVENT2}) \multimap \uparrow_\sigma] \multimap \\ \quad (\uparrow \text{OBJ})_\sigma \multimap \uparrow_\sigma \end{array}$$

The argument of the SWEDISH-DMC template is called "FN" in this definition; it is passed as an argument to the TRANSITIVE-OBLIQUE template, which is defined in (24). Besides the two template calls, SWEDISH-DMC also contributes a meaning constructor to complete the meaning of the Swedish construction, which requires the following:

- a meaning Q depending on the OBL phrase, specifying the nature of the path traversed; for (12) ($\sim$'Sarah elbowed her way through the crowd'), the path is required to go through the crowd.
- a meaning P, contributed by the main verb, specifying the nature of the event e denoted by the main verb and its relation to the transition event e'; for (12) ($\sim$'Sarah elbowed her way through the crowd'), e is an elbowing event and is the means enabling the traversal event e'.
- a meaning y for the object of the main verb, which is required to be a reflexive and hence to corefer with the subject of the main verb; y is the theme of e', the traversal event.

Our analysis produces the meaning in (22) for *Sarah armbågade sig genom mängden* 'Sarah elbowed SELF through the crowd'.

(22) $$\begin{array}{l} \exists e.\exists e'.\exists z.elbow(e) \wedge agent(e) = sarah \wedge cause(e') = sarah \wedge means(e', e) \wedge \\ \quad traversal(e') \wedge theme(e') = sarah \wedge path(e') = z \wedge through(z, \iota x.[crowd(x)]) \end{array}$$

A full proof of the derivation of this meaning is given in the Appendix.

4.2 Verb lexicon and basic subcategorization templates

We have seen that the SWEDISH-DMC template provides a PRED specification with subcategorization frame and semantic specifications for the construction. This in turn means that the lexical entry for a verb must supply a default PRED and semantics which can be overridden when the verb is used in a construction like the *way*-construction.[2] We assume that the verb *elbowed/armbågade*, which appears in (6) and (12), is specified as follows:

(23) elbowed/armbågade V $\lambda e.elbow(e) : (\uparrow_\sigma \text{ REL})$

$$\left(\begin{array}{l} \text{@TRANSITIVE(elbow)} \\ \lambda R \lambda x \lambda y \exists e.R(e) \ \wedge \ agent(e) = x \ \wedge \ theme(e) = y: \\ (\uparrow_\sigma \text{REL}) \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow \text{OBJ})_\sigma \multimap \uparrow_\sigma \end{array}\right)$$

The first line of the entry specifies its s-structure semantic REL(ATION). The second part of the entry specifies a default semantic contribution and subcategorization information, encoded by the template TRANSITIVE and the meaning constructor in the third line. This material effectively serves as a default, because unless some other part of the system specifies an alternative, constructional GF template, there is no way to check Completeness and Coherence and the structure will fail.

The TRANSITIVE template takes a single argument, here 'elbow'. The definition of TRANSITIVE is stated with respect to an arbitrary argument FN:[3]

(24) TRANSITIVE(FN) = (↑ PRED) = 'FN⟨(↑ SUBJ),(↑ OBJ)⟩'
TRANSITIVE-OBLIQUE(FN) = (↑ PRED) = 'FN⟨(↑ SUBJ),(↑ OBJ),(↑ OBL)⟩'

The argument FN of the TRANSITIVE template appears in parentheses after the template name, and also appears in the definition of the template as the FN of the semantic form. Notice that FN is not itself a semantic form, but rather part of a semantic form; the attribute FN and argument designators such as ARG1 allow reference to the components of a semantic form (Crouch et al. 2008) according to the following pattern:

(25) [PRED 'FN⟨ARG1,ARG2,...⟩']

The specifications in (26) are equivalent:

(26) a. (f PRED) = 'elbow⟨(↑ SUBJ),(↑ OBJ)⟩'
b. (f PRED FN) = elbow
(f PRED ARG1) = (↑ SUBJ)
(f PRED ARG2) = (↑ OBJ)

For the verb *elbow*, the call to the TRANSITIVE template passes in the argument 'elbow'. The template call @TRANSITIVE(elbow) is exactly equivalent to the following equation:

(27) (↑ PRED) = 'elbow⟨(↑ SUBJ),(↑ OBJ)⟩'

We now turn to the default meaning constructor for *elbow* given in (23), repeated here:

(28) $\lambda R \lambda x \lambda y \exists e.R(e) \ \wedge \ agent(e) = x \ \wedge \ theme(e) = y$:
$(\uparrow_\sigma \text{REL}) \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow \text{OBJ})_\sigma \multimap \uparrow_\sigma$

This meaning constructor requires a REL R which is supplied by the verb (the REL for the verb *elbow* is specified above as $\lambda e.elbow(e)$), a meaning x for the SUBJ, and a meaning y for the OBJ. For a sentence like *Bill elbowed Fred*, the meaning that is produced is, as desired:

(29) $\exists e.elbow(e) \ \wedge \ agent(e) = Bill \wedge \ theme(e) = Fred$

When the verb *elbowed* is used in the traversal construction, these default specifications are overridden by the specifications imposed by the construction, and the special constructional specifications are used instead.

[2] Our analysis of the Swedish DMC and the English *way*-construction involves **replacing** rather than **modifying** the default semantic form of the main verb with the specifications provided by the construction. In the analysis of other constructions, it may be preferable to modify the semantic form via restriction or other operators, as proposed for the analysis of complex predicates by Butt et al. (2003) (see also Butt and King 2005 on causatives).

[3] For ease of explication, (24) specifies an active subcategorization frame for the verb, simplifying away from mapping theory issues and the possibility for passivization of this verb. We return to a discussion of the interaction of mapping theory and our theory of constructions in Section 6 below, where we propose a revised TRANSITIVE template which refers to argument structure roles rather than grammatical functions and which interacts appropriately with mapping theory.

4.3 Lexically flagged constructions

The English *way*-construction relies on many of the same templates as the Swedish DMC. It is different in that it is completely regular in terms of phrasal structure, so no exceptional phrase structure rule is required. Rather, we assume the standard V′ rule for English, which already permits an NP OBJECT and a PP OBLIQUE. Evidence that the PP is an argument of the main verb and not a modifier of *way* comes from adverb placement: it is possible for an adverb to intervene between *way* and the PP, while this is not possible if the PP is associated with the object:

(30) Sarah elbowed her way quickly through the crowd.

(31) *Sarah elbowed a friend quickly of her mother's.

The locus of the English *way*-construction is the word *way*, which receives the following specification:

(32) way N $(\uparrow \text{PRED}) = \text{'way'}$
$\lambda x.way(x) : (\uparrow_\sigma \text{ VAR}) \multimap (\uparrow_\sigma \text{ RESTR})$
(@ENGLISH-WAY((OBJ ↑) PRED FN))

According to this lexical entry, *way* contributes a semantic form 'way' and a standard noun meaning $\lambda x.way(x)$ on every occasion of its use, even in the *way*-construction. As we will see, our analysis equates the path specified in the ENGLISH-WAY template with the path denoted by *way*. Retaining the standard semantics for *way* allows us to provide a satisfactory analysis of modification of *way* and specification of possessors of *way* other than the subject, as discussed in Section 2.1; the relevant examples are:

(33) a. As ambassador, Chesterfield negotiated **Britain's way** into the Treaty of Vienna in 1731.

b. In these last twenty years Richard Strauss has flamed **his meteoric way** into our ken — and out of it.

The ENGLISH-WAY constructional template appears in parentheses, since it is an optional contribution of the word *way*. Its argument is ((OBJ ↑) PRED FN): this expression uses inside-out functional uncertainty to refer to the f-structure in which *way* is an OBJ, (OBJ ↑), and passes the PRED FN of that f-structure as an argument to the template.

The definition of the ENGLISH-WAY template is:

(34) ENGLISH-WAY(FN) = @TRANSITIVE-OBLIQUE(FN)
{@TRAVERSAL-MEANS | @TRAVERSAL-MANNER}

$$\begin{array}{l}\lambda Y \lambda Q \lambda P \lambda x.\exists e.\exists e'.\exists z.P(e)(e') \wedge \\ \quad theme(e') = x \wedge path(e') = z \wedge \\ \quad\quad Q(z) \wedge z = Y(x) : \\ [(\uparrow \text{SPEC})_\sigma \multimap \uparrow_\sigma] \multimap \\ \quad [(((\text{OBJ}\ \uparrow)\ \text{OBL})_\sigma\ \text{PATH}) \multimap ((\text{OBJ}\ \uparrow)\ \text{OBL})_\sigma] \multimap \\ \quad\quad [((\text{OBJ}\ \uparrow)_\sigma\ \text{EVENT1}) \multimap ((\text{OBJ}\ \uparrow)_\sigma\ \text{EVENT2}) \multimap (\text{OBJ}\ \uparrow)_\sigma] \multimap \\ \quad\quad\quad (\uparrow \text{SPEC})_\sigma \multimap (\text{OBJ}\ \uparrow)_\sigma\end{array}$$

As shown in (14), this definition calls the TRANSITIVE-OBLIQUE template and passes in the FN of the main verb, providing the semantic form and subcategorization specification for the construction. The second line contains a disjunction: either the TRAVERSAL-MEANS or the TRAVERSAL-MANNER template is called. This is because the English *way*-construction allows either a means interpretation for the construction or a manner interpretation. The TRAVERSAL-MANNER template is defined in (35) in terms of template calls to the TRAVERSAL and MANNER templates:

(35) TRAVERSAL-MANNER = @TRAVERSAL
@MANNER

The MANNER template is similar to the MEANS template defined in (20), except that it specifies that a relation R is the manner by which the event e' is achieved, rather than the means:

(36) MANNER = $\lambda P \lambda R \lambda e'.P(R)(e') \wedge manner(e', R)$:
$[(\uparrow_\sigma \text{ REL}) \multimap (\uparrow_\sigma \text{ EVENT2}) \multimap \uparrow_\sigma] \multimap [(\uparrow_\sigma \text{ REL}) \multimap (\uparrow_\sigma \text{ EVENT2}) \multimap \uparrow_\sigma]$

Besides the template calls in the first two lines, the ENGLISH-WAY template contributes the following meaning constructor:

(37)
$$\begin{array}{l}\lambda Y \lambda Q \lambda P \lambda x.\exists e.\exists e'.\exists z.P(e)(e') \wedge \\ \quad theme(e') = x \wedge path(e') = z \wedge \\ \quad\quad Q(z) \wedge z = Y(x) : \\ [(\uparrow \text{SPEC})_\sigma \multimap \uparrow_\sigma] \multimap \\ \quad [(((\text{OBJ} \uparrow) \text{ OBL})_\sigma \text{ PATH}) \multimap ((\text{OBJ} \uparrow) \text{ OBL})_\sigma] \multimap \\ \quad\quad [((\text{OBJ} \uparrow)_\sigma \text{ EVENT1}) \multimap ((\text{OBJ} \uparrow)_\sigma \text{ EVENT2}) \multimap (\text{OBJ} \uparrow)_\sigma] \multimap \\ \quad\quad\quad (\uparrow \text{SPEC})_\sigma \multimap (\text{OBJ} \uparrow)_\sigma\end{array}$$

This meaning constructor requires:

- a meaning Y for the *way* NP, which provides additional information about the path z that is traversed
- a meaning Q for the oblique phrase; for the example *Sarah elbowed her way through the crowd*, this is the meaning of *through the crowd*, which characterizes the path z
- a meaning P, contributed by the main verb, specifying the nature of the event e and its relation to the traversal event; for (12) (*Sarah elbowed her way through the crowd*), e is required to be an elbowing event and is the means enabling the traversal event
- a meaning x for the possessor of *way*, which plays the role of the theme of the traversal event e'.

This analysis produces the meaning in (38) for *Sarah elbowed her way through the crowd*:

(38)
$$\begin{array}{l}\exists e.\exists e'.\exists z.elbow(e) \wedge agent(e) = sarah \wedge \\ \quad cause(e') = sarah \wedge means(e', e) \wedge traversal(e') \wedge theme(e') = sarah \wedge \\ \quad\quad path(e') = z \wedge through(z, \iota x.[crowd(x)]) \wedge z = \iota y.[way(y) \wedge R_c(sarah, y)]\end{array}$$

The main difference between this meaning and the meaning of its Swedish counterpart *Sarah armbågade sig genom mängden* is that the English *way*-construction provides a more detailed specification of the path z. We follow Partee (1983/1997) and Partee and Borschev (1998) in treating the genitive construction as involving reference to a unique individual who bears some contextually specified relation R_c to a possessor. The possessive pronoun in the phrase *her way* is resolved to the subject *Sarah*, and the meaning of *her way* is analyzed as $\iota y.[way(y) \wedge R_c(sarah, y)]$, the unique y that is a way and that bears the relation R_c to Sarah. This analysis enables us to treat cases in which *way* is modified or possessed by an individual other than the subject of the construction. A full proof of the meaning of *Sarah elbowed her way through the crowd* is given in the Appendix.

5 Traversal constructions across the Germanic languages

Many Germanic languages have traversal constructions comparable to the English *way*-construction and the Swedish DMC. It is likely that all Germanic languages have traversal constructions of some kind.

5.1 Dutch

Van Egmond (2006) shows that Dutch has two constructions that indicate traversal of a path. One construction contains the word *weg* 'way' (39), and the other does not (40).

(39) Wij worstelen ons een weg door de menigte. Dutch
we wrestle ourselves a way through the crowd
'We are wrestling our way through the crowd.'

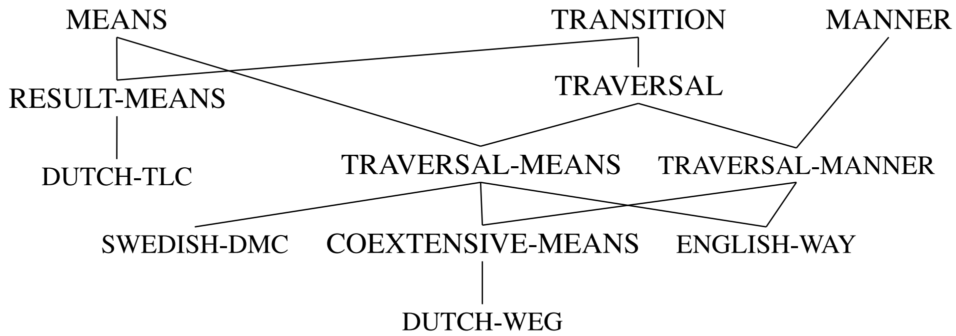
(40) Janneke bluft zich uit de benarde situatie.
J. bluffs SELF out the awkward situation
'Janneke bluffs her way out of the awkward situation.'

The *weg*-construction exemplified in (39) is also discussed in Verhagen (2003).

Although the two Dutch constructions are similar in meaning, van Egmond (2006) shows that they nevertheless have distinct interpretations. She calls the type with *weg* (39) the '*weg*-construction' (DUTCH-WEG), and the type with a reflexive (40) the 'Transition to Location' (DUTCH-TLC) construction. The *weg*-construction describes an incremental traversal of a path by means of (or while) performing the activity denoted by the verb. The traversal and the activity denoted by the verb are coidentified: the construction describes a simple event. The TLC, on the other hand, describes a transition to a stative location by means of performing the activity denoted by the verb, without necessarily traversing a path. The traversal and the activity denoted by the verb are two subevents that are not necessarily coextensive. For example, in (40), the bluffing event can take place at a preceding point in time than the second event, in which the subject gets out of the awkward situation.

We propose the following additions to the template hierarchy in (14) for Dutch:

(41)



This template hierarchy includes several new templates. COEXTENSIVE-MEANS specifies that the event denoted by the main verb and the traversal event are coextensive:

(42) COEXTENSIVE-MEANS = {@TRAVERSAL-MEANS | @TRAVERSAL-MANNER}

$$\lambda P \lambda e \lambda e'.P(e)(e') \ \wedge \ coextensive(e,e') :$$
$$[(\uparrow_\sigma \text{EVENT1}) \multimap (\uparrow_\sigma \text{EVENT2}) \multimap \uparrow_\sigma] \multimap$$
$$[(\uparrow_\sigma \text{EVENT1}) \multimap (\uparrow_\sigma \text{EVENT2}) \multimap \uparrow_\sigma]$$

This template is used in the definition of the DUTCH-WEG template, which, like English, allows either a means or a manner interpretation.

The TLC construction is defined in terms of the RESULT-MEANS template, defined as:

(43) RESULT-MEANS = @TRANSITION
@MEANS

$$\lambda P \lambda e \lambda e'.P(e)(e') \ \wedge \ result(e,e') :$$
$$[(\uparrow_\sigma \text{EVENT1}) \multimap (\uparrow_\sigma \text{EVENT2}) \multimap \uparrow_\sigma] \multimap$$
$$[(\uparrow_\sigma \text{EVENT1}) \multimap (\uparrow_\sigma \text{EVENT2}) \multimap \uparrow_\sigma]$$

RESULT-MEANS involves a transition but not necessarily a traversal, and so is defined in terms of the TRANSITION template. It specifies a means interpretation (and disallows a manner interpretation), and so incorporates the MEANS template in its definition. Besides incorporating information from these templates, RESULT-MEANS specifies that the event denoted by the verb results in a transition to a state e' specified by the oblique phrase.

5.2 German

German also has two traversal constructions (Ludwig 2005). Ludwig provides the following two examples:

(44) Der Song stampft sich seinen Weg ins Unterbewusstsein. German
the song stomps self its way into.the subconscious
'The song stomps its way into the subconscious.'

(45) Er bettelt sich durchs Land.
he begs self through.the country
'He begs his way through the country.'

Ludwig points out that the construction in (44) is less productive or common than (45). She also notes that the possessive pronoun can be replaced by an indefinite or definite article. Since the two Dutch constructions were shown to differ in interpretation (van Egmond 2006), it would be interesting to investigate whether the German constructions differ as well.

5.3 Norwegian

Seland (2001) and Sveen (2002) discuss Norwegian examples which are very similar to Swedish DMC examples. Example (46) is Seland's example (4b).

(46) Hun har skutt seg til sommer-OL. Norwegian
she has shot herself to summer-Olympics
'She has shot her way to the Summer Olympics.'

Verbal particles behave quite differently in Swedish and Norwegian. Norwegian does not display a word order difference between traversal and resultative examples. However, Norwegian speakers indicate that a difference in intonation may serve to differentiate between the two (Øystein Nilsen and Helge Lødrup, p.c.).

We expect that investigation of these constructions in the Germanic languages will turn up interesting differences and similarities with English, Swedish, and Dutch, and will likely lead to augmentations and refinements to the template hierarchy that we have proposed. For example, van Egmond proposes that the English way-construction is in fact ambiguous between the traversal meaning of the Dutch way-construction and the transition meaning of the Dutch TLC, and this is not reflected in our hierarchy. In addition, there may well be distinctions and generalizations that have not yet been discovered.

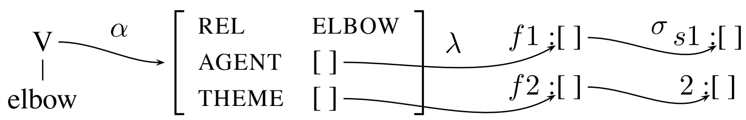
6 Linking

We now return to the definition of syntactic subcategorization requirements in the templates that appear as defaults in verbal lexical entries and as specifications of subcategorisation requirements in the *way*- and DMC constructions. Recall that for simplicity, we assumed that the relation between semantic roles and grammatical functions is fixed by the construction or by information in the lexical entry of a predicate. For example, the default subcategorization for a verb like *elbowed/armbågade* was given by the TRANSITIVE template, defined in (24) as:

(47) TRANSITIVE(FN) = $(\uparrow$ PRED$)$ = 'FN$\langle(\uparrow$ SUBJ$),(\uparrow$ OBJ$)\rangle$'

This is overly inflexible; the correct analysis would specify argument structure information for the predicate or construction rather than a specific set of grammatical functions, and would appeal to some version of Mapping Theory (Bresnan and Zaenen 1990, Alsina 1993, Butt 1995, Butt et al. 1997) to derive the syntactic subcategorization frame for the predicate from argument structure. We sketch here how this would work for the lexical specifications for the verb *elbow*, following the approach of Butt et al. (1997).

Butt et al. (1997) assume the following projection architecture:

(48)


Argument structure is represented as an attribute-value matrix reachable from the c-structure via the α projection. The familiar ϕ projection is defined as the composition of the α projection to argument structure and the λ projection from argument structure to f-structure.

The lexical entry for *elbowed/armbågade* can now be stated as:

(49) elbowed/armbågade V $\lambda e.elbow(e) : (\uparrow_\sigma \text{REL})$

$$\left(\begin{array}{l} (\uparrow \text{PRED FN}) = \text{elbow} \\ \lambda R\lambda x\lambda y\lambda e.R(e) \;\wedge\; agent(e) = x \;\wedge\; theme(e) = y\text{:} \\ (\uparrow_\sigma \text{REL}) \multimap (\widehat{*}_\alpha\ \text{AGENT})\lambda\sigma \multimap (\widehat{*}_\alpha\ \text{THEME})\lambda\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma \end{array}\right)$$

Instead of specifying the grammatical functions SUBJ and OBJ, this lexical entry specifies that the argument structure of the verb contains an AGENT and a THEME. These will be linked to the appropriate grammatical functions according to mapping theory.

The English *way*-construction and the Swedish DMC construction could be treated similarly, with argument structure roles specified in the templates for the construction, and the mapping from argument structure roles to grammatical functions provided by mapping theory. However, these constructions do in fact seem to be syntactically inflexible, and cannot undergo passivization or other argument alternations:

(50) *Bill's way through the park was elbowed (by him).

Given this, we propose to leave the templates appearing in those constructions in their current form, since we believe that specifying particular grammatical functions and disallowing argument alternations such as passive is the right treatment for these.

7 Conclusion

Our approach captures the intuitions of CG in LFG without giving up Lexical Integrity and without in any sense admitting constructions as first-class entities in the theory (unlike, e.g., the HPSG approach of Sag 1997 and certain subsequent HPSG work). LFG templates, which have been independently motivated for reasons of expediency in grammar writing, now play a crucial theoretical role: templates serve as the locus of grammatical information that can be either lexically or structurally invoked and thus formalize one aspect of the lexicon–syntax interface. In order to accommodate this view of constructions, the verbal lexicon needs to be modified such that subcategorization is now strictly governed by the template component.

References

Alsina, Alex. 1993. Predicate Composition: A Theory of Syntactic Function Alternations. Ph.D. thesis, Stanford University.

Asudeh, Ash. 2004. Resumption as Resource Management. Ph.D. thesis, Stanford University.

Bresnan, Joan. 2001. *Lexical-Functional Syntax*. Oxford: Blackwell Publishers.

Bresnan, Joan, and Annie Zaenen. 1990. Deep Unaccusativity in LFG. In Katarzyna Dziwirek, Patrick Farrell, and Errapel Mejías-Bikandi, eds., *Grammatical Relations: A Cross-Theoretical Perspective*, 45–57. Stanford, CA: CSLI Publications.

Buchanan, Charles L. 1918. Ornstein and Modern Music. *The Musical Quarterly* 4(2): 174–183.

Butt, Miriam. 1995. *The Structure of Complex Predicates in Urdu*. Dissertations in Linguistics. Stanford, CA: CSLI Publications. Revised and corrected version of 1993 Stanford University dissertation.

Butt, Miriam, Mary Dalrymple, and Anette Frank. 1997. An architecture for linking theory in LFG. In Miriam Butt and Tracy Holloway King, eds., *On-line Proceedings of the LFG97 Conference*.

Butt, Miriam, and Tracy Holloway King. 2005. Restriction for Morphological Valency Alternations: The Urdu Causative. In Miriam Butt and Tracy Holloway King, eds., *On-line Proceedings of the LFG2005 Conference*.

Butt, Miriam, Tracy Holloway King, and John T. Maxwell. 2003. Productive encoding of Urdu complex predicates in the ParGram Project. In *Proceedings of the EACL03 Workshop on Computational Linguistics for South Asian Languages: Expanding Synergies with Europe*, 9–13.

Crouch, Dick, Mary Dalrymple, Ron Kaplan, Tracy King, John Maxwell, and Paula Newman. 2008. *XLE Documentation*. Palo Alto Research Center, Palo Alto, CA.

Culicover, Peter W., and Ray Jackendoff. 1999. The View from the Periphery: The English Comparative Correlative. *Linguistic Inquiry* 30(4): 543–572.

Dalrymple, Mary, ed. 1999. *Semantics and Syntax in Lexical Functional Grammar: The Resource Logic Approach*. Cambridge, MA: The MIT Press.

Dalrymple, Mary. 2001. *Lexical Functional Grammar*, vol. 34 of *Syntax and Semantics*. New York, NY: Academic Press.

Dalrymple, Mary, Ronald M. Kaplan, and Tracy Holloway King. 2004. Linguistic Generalizations over Descriptions. In Miriam Butt and Tracy Holloway King, eds., *On-line Proceedings of the LFG2004 Conference*.

Dalrymple, Mary, Ronald M. Kaplan, John T. Maxwell, III, and Annie Zaenen, eds. 1995. *Formal Issues in Lexical-Functional Grammar*. Stanford, CA: CSLI Publications.

Fillmore, Charles. 1988. The mechanisms of 'Construction Grammar'. In Shelley Axmaker, Annie Jaisser, and Helen Singmaster, eds., *Proceedings of Fourteenth Annual Meeting of the Berkeley Linguistics Society*, 35–55. Berkeley: Berkeley Linguistics Society.

Fillmore, Charles J., Paul Kay, and Mary Catherine O'Connor. 1988. Regularity and idiomaticity in grammatical constructions: The case of *let alone*. *Language* 64: 501–538.

Goldberg, Adele E. 1995. *Constructions: A Construction Grammar Approach to Argument Structure*. Chicago: University of Chicago Press.

Jackendoff, Ray S. 1990. *Semantic Structures*. Cambridge, MA: The MIT Press.

Janssen, Theo M. V. 1997. Compositionality. In *Handbook of Logic and Language*, 419–473. Cambridge and Amsterdam: The MIT Press/Elsevier.

Kaplan, Ronald M., and Joan Bresnan. 1982. Lexical-Functional Grammar: A Formal System for Grammatical Representation. In Joan Bresnan, ed., *The Mental Representation of Grammatical Relations*, 173–281. Cambridge, MA: The MIT Press. Reprinted in Dalrymple et al. (1995:29–130).

Kay, Paul, and Charles J. Fillmore. 1999. Grammatical Constructions and Linguistic Generalizations: the *What's X doing Y?* Construction. *Language* 75: 1–33.

Ludwig, Ilka. 2005. The *way*-construction in German. MS, University of Canterbury.

Partee, Barbara. 1983/1997. Genitives — A Case Study. In Johan van Benthem and Alice ter Meulen, eds., *Handbook of Logic and Language*, 464–470. Amsterdam and Boston: Elsevier/The MIT Press. Appendix to Janssen (1997). Published version of 1983 manuscript.

Partee, Barbara, and Vladimir Borschev. 1998. Integrating lexical and formal semantics: Genitives, relational nouns, and type-shifting. In Robin Cooper and Thomas Gamkrelidze, eds., *Proceedings of the Second Tbilisi Symposium on Language, Logic, and Computation*, 229–241. Tbilisi: Center on Language, Logic, Speech, Tbilisi State University.

Sadler, Louisa, and Andrew Spencer, eds. 2004. *Paradigms and Periphrastic Expression: A Study in Realization-Based Lexicalism*. Stanford, CA: CSLI Publications.

Sag, Ivan A. 1997. English Relative Clause Constructions. *Journal of Linguistics* 33(4): 431–484.

Seland, Grete. 2001. The Norwegian Reflexive Caused Motion Construction: A Construction Grammar Approach. Cand. philol. thesis., department of linguistics, University of Oslo.

Sveen, Andreas. 2002. Konstruksjonens betydning for betydningen: *å verbe seg til* MÅL. *Norsk Lingvistisk Tidsskrift* 20: 3–26.

Toivonen, Ida. 2002. The directed motion construction in Swedish. *Journal of Linguistics* 38: 313–345.

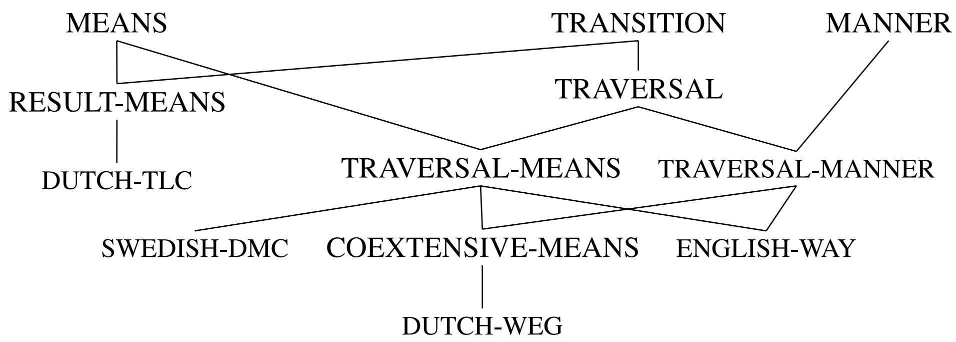
van Egmond, Marie-Elaine. 2006. Two way-constructions in Dutch. Master's thesis, University of Canterbury, Christchurch, New Zealand.

Verhagen, Arie. 2003. The Dutch Way. In Arie Verhagen and Jeroen M. van de Weijer, eds., *Usage-Based Approaches to Dutch*, 27–57. Utrecht: LOT.

Appendices

A Template Hierarchy

(51)



B Templates

(52) TRANSITION $=$ $\lambda R \lambda x \lambda e \lambda e'.R(e) \wedge agent(e) = x \wedge cause(e') = x :$
$(\uparrow_\sigma \text{REL}) \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT1}) \multimap (\uparrow_\sigma \text{EVENT2}) \multimap \uparrow_\sigma$

(53) MEANS $=$ $\lambda P \lambda e \lambda e'.P(e)(e') \wedge means(e', e) :$
$[(\uparrow_\sigma \text{EVENT1}) \multimap (\uparrow_\sigma \text{EVENT2}) \multimap \uparrow_\sigma] \multimap [(\uparrow_\sigma \text{EVENT1}) \multimap (\uparrow_\sigma \text{EVENT2}) \multimap \uparrow_\sigma]$

(54) MANNER $=$ $\lambda P \lambda R \lambda e'.P(R)(e') \wedge manner(e', R) :$
$[(\uparrow_\sigma \text{REL}) \multimap (\uparrow_\sigma \text{EVENT2}) \multimap \uparrow_\sigma] \multimap [(\uparrow_\sigma \text{REL}) \multimap (\uparrow_\sigma \text{EVENT2}) \multimap \uparrow_\sigma]$

(55) TRAVERSAL $=$ @TRANSITION
$\lambda P \lambda e'.P(e') \wedge traversal(e') :$
$[(\uparrow_\sigma \text{EVENT2}) \multimap \uparrow_\sigma] \multimap [(\uparrow_\sigma \text{EVENT2}) \multimap \uparrow_\sigma]$

(56) TRAVERSAL-MEANS $=$ @TRAVERSAL
@MEANS

(57) TRAVERSAL-MANNER $=$ @TRAVERSAL
@MANNER

(58) SWEDISH-DMC(FN) $=$ @TRANSITIVE-OBLIQUE(FN)
@TRAVERSAL-MEANS
$\lambda Q \lambda P \lambda y.\exists e.\exists e'.\exists z.P(e)(e') \wedge$
$theme(e') = y \wedge path(e') = z \wedge Q(z) :$
$[((\uparrow \text{OBL})_\sigma \text{PATH}) \multimap (\uparrow \text{OBL})_\sigma] \multimap$
$[(\uparrow_\sigma \text{EVENT1}) \multimap (\uparrow_\sigma \text{EVENT2}) \multimap \uparrow_\sigma] \multimap$
$(\uparrow \text{OBJ})_\sigma \multimap \uparrow_\sigma$

(59) ENGLISH-WAY(FN) = @TRANSITIVE-OBLIQUE(FN)
{@TRAVERSAL-MEANS | @TRAVERSAL-MANNER}

$$\begin{array}{l}\lambda Y \lambda Q \lambda P \lambda x.\exists e.\exists e'.\exists z.P(e)(e') \ \wedge \\ \quad theme(e') = x \ \wedge \ path(e') = z \ \wedge \\ \quad\quad Q(z) \ \wedge \ z = Y(x) : \\ [(\uparrow \textsc{spec})_\sigma \multimap \uparrow_\sigma] \multimap \\ \quad [(((\textsc{obj}\ \uparrow)\ \textsc{obl})_\sigma\ \textsc{path}) \multimap ((\textsc{obj}\ \uparrow)\ \textsc{obl})_\sigma] \multimap \\ \quad\quad [((\textsc{obj}\ \uparrow)_\sigma\ \textsc{event1}) \multimap ((\textsc{obj}\ \uparrow)_\sigma\ \textsc{event2}) \multimap (\textsc{obj}\ \uparrow)_\sigma] \multimap \\ \quad\quad\quad (\uparrow \textsc{spec})_\sigma \multimap (\textsc{obj}\ \uparrow)_\sigma\end{array}$$

(60) COEXTENSIVE-MEANS = {@TRAVERSAL-MEANS | @TRAVERSAL-MANNER}

$$\begin{array}{l}\lambda P \lambda e \lambda e'.P(e)(e') \ \wedge \ coextensive(e, e') : \\ [(\uparrow_\sigma \textsc{event1}) \multimap (\uparrow_\sigma \textsc{event2}) \multimap \uparrow_\sigma] \multimap \\ \quad [(\uparrow_\sigma \textsc{event1}) \multimap (\uparrow_\sigma \textsc{event2}) \multimap \uparrow_\sigma]\end{array}$$

(61) RESULT-MEANS = @TRANSITION
@MEANS

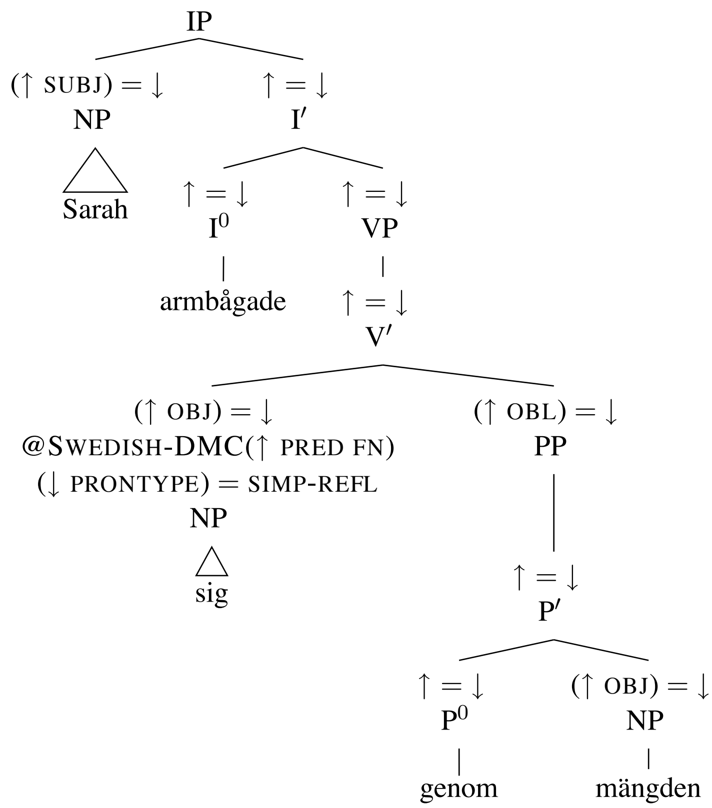
$$\begin{array}{l}\lambda P \lambda e \lambda e'.P(e)(e') \ \wedge \ result(e, e') : \\ [(\uparrow_\sigma \textsc{event1}) \multimap (\uparrow_\sigma \textsc{event2}) \multimap \uparrow_\sigma] \multimap \\ \quad [(\uparrow_\sigma \textsc{event1}) \multimap (\uparrow_\sigma \textsc{event2}) \multimap \uparrow_\sigma]\end{array}$$

C Examples

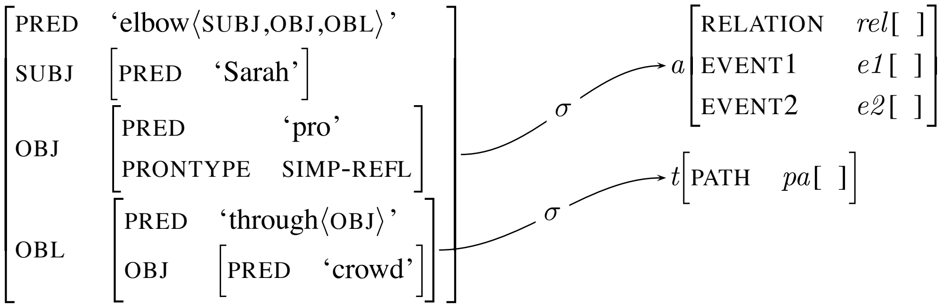
C.1 Swedish

(62) Sarah armbågade sig genom mängden.
S. elbowed SELF through crowd.DEF

(63)



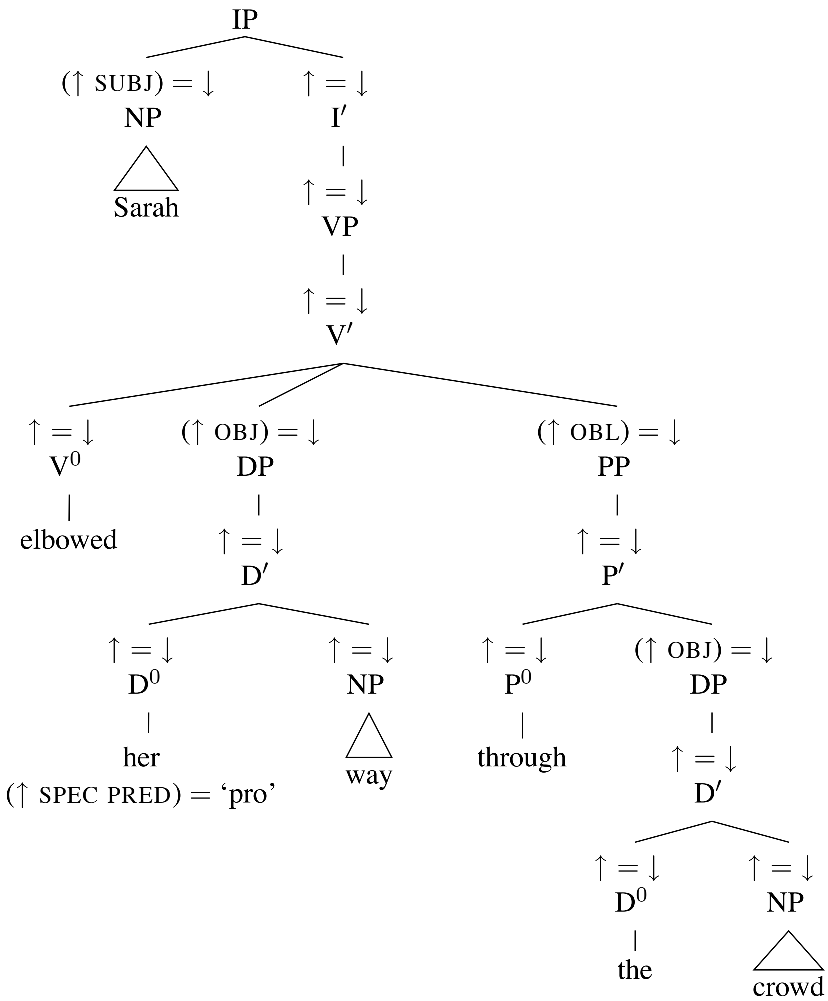
(64)



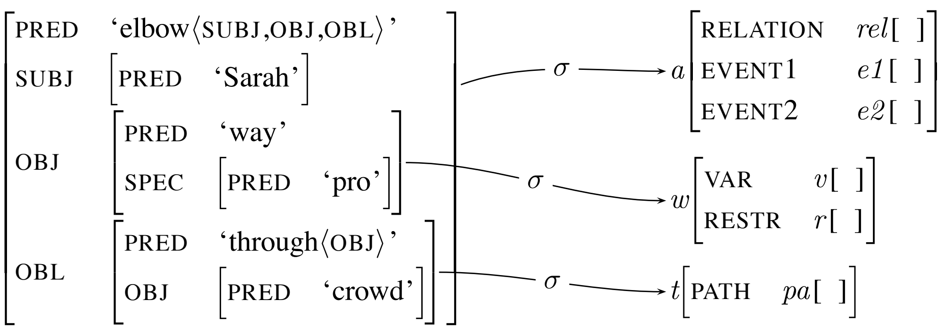
C.2 English

(65) Sarah elbowed her way through the crowd.

(66)



(67)



C.3 Glue Proofs

$$\dfrac{\begin{array}{l}\textbf{armbågade}\\ \lambda e.elbow(e) :\\ rel\end{array} \qquad \begin{array}{l}\textsc{Transition}\\ \lambda R\lambda x\lambda e\lambda e'.R(e) \wedge\\ \quad agent(e)=x \wedge\\ \quad cause(e')=x :\\ rel \multimap s \multimap e1 \multimap e2 \multimap a\end{array}}{\begin{array}{l}\lambda x\lambda e\lambda e'.elbow(e) \wedge\\ \quad agent(e)=x \wedge\\ \quad cause(e')=x :\\ s \multimap e1 \multimap e2 \multimap a\end{array}}$$

$$\dfrac{[y_1 : s]^1 \qquad \begin{array}{l}\lambda x\lambda e\lambda e'.elbow(e) \wedge agent(e)=x \wedge cause(e')=x :\\ s \multimap e1 \multimap e2 \multimap a\end{array}}{\begin{array}{l}\lambda e\lambda e'.elbow(e) \wedge\\ \quad agent(e)=y_1 \wedge cause(e')=y_1 :\\ e1 \multimap e2 \multimap a\end{array}}$$

$$\dfrac{\begin{array}{l}\lambda e\lambda e'.elbow(e) \wedge agent(e)=y_1 \wedge cause(e')=y_1 :\\ e1 \multimap e2 \multimap a\end{array} \qquad \begin{array}{l}\textsc{Means}\\ \lambda P\lambda e\lambda e'.P(e)(e') \wedge\\ \quad means(e',e) :\\ (e1 \multimap e2 \multimap a) \multimap\\ \quad (e1 \multimap e2 \multimap a)\end{array}}{\begin{array}{l}\lambda e\lambda e'.elbow(e) \wedge agent(e)=y_1 \wedge\\ \quad cause(e')=y_1 \wedge means(e',e) :\\ e1 \multimap e2 \multimap a\end{array}}$$

$$\dfrac{[e'' : e1]^3 \qquad \begin{array}{l}\lambda e\lambda e'.elbow(e) \wedge agent(e)=y_1 \wedge\\ \quad cause(e')=y_1 \wedge means(e',e) :\\ e1 \multimap e2 \multimap a\end{array}}{\begin{array}{l}\lambda e'.elbow(e'') \wedge agent(e'')=y_1 \wedge\\ \quad cause(e')=y_1 \wedge means(e',e'') : e2 \multimap a\end{array}}$$

$$\dfrac{\begin{array}{l}\lambda e'.elbow(e'') \wedge agent(e'')=y_1 \wedge\\ \quad cause(e')=y_1 \wedge means(e',e'') : e2 \multimap a\end{array} \qquad \begin{array}{l}\textsc{Traversal}\\ \lambda P\lambda e'.P(e') \wedge traversal(e') :\\ (e2 \multimap a) \multimap (e2 \multimap a)\end{array}}{\begin{array}{l}\lambda e'.elbow(e'') \wedge agent(e'')=y_1 \wedge\\ \quad cause(e')=y_1 \wedge means(e',e'') \wedge traversal(e') : e2 \multimap a\end{array}}$$

$$\dfrac{\begin{array}{l}\lambda e'.elbow(e'') \wedge agent(e'')=y_1 \wedge\\ \quad cause(e')=y_1 \wedge means(e',e'') \wedge traversal(e') : e2 \multimap a\end{array}}{\begin{array}{l}\lambda e''\lambda e'.elbow(e'') \wedge agent(e'')=y_1 \wedge\\ \quad cause(e')=y_1 \wedge means(e',e'') \wedge traversal(e') : e1 \multimap e2 \multimap a\end{array}}\ {\multimap}_{\mathcal{I},3}$$

$$\dfrac{\begin{array}{l}\textbf{genom}\\ \lambda z\lambda y.through(y,z) :\\ m \multimap pa \multimap t\end{array} \qquad \begin{array}{l}\textbf{mängden}\\ \iota x.[crowd(x)] :\\ m\end{array}}{\lambda y.through(y,\iota x.[crowd(x)]) : pa \multimap t}$$

$$\dfrac{\begin{array}{l}\textsc{Swedish-DMC}\\ \lambda Q\lambda P\lambda y.\exists e.\exists e'.\exists z.P(e)(e') \wedge\\ \quad theme(e')=y \wedge path(e')=z \wedge Q(z) :\\ (pa \multimap t) \multimap (e1 \multimap e2 \multimap a) \multimap p \multimap a\end{array} \qquad \lambda y.through(y,\iota x.[crowd(x)]) : pa \multimap t}{\begin{array}{l}\lambda P\lambda y.\exists e.\exists e'.\exists z.P(e)(e') \wedge\\ \quad theme(e')=y \wedge path(e')=z \wedge through(z,\iota x.[crowd(x)]) :\\ (e1 \multimap e2 \multimap a) \multimap p \multimap a\end{array}}$$

$$\dfrac{\begin{array}{l}\lambda e''\lambda e'.elbow(e'') \wedge agent(e'')=y_1 \wedge\\ \quad cause(e')=y_1 \wedge means(e',e'') \wedge traversal(e') : e1 \multimap e2 \multimap a\end{array} \qquad \begin{array}{l}\lambda P\lambda y.\exists e.\exists e'.\exists z.P(e)(e') \wedge\\ \quad theme(e')=y \wedge path(e')=z \wedge through(z,\iota x.[crowd(x)]) :\\ (e1 \multimap e2 \multimap a) \multimap p \multimap a\end{array}}{\begin{array}{l}\lambda y.\exists e.\exists e'.\exists z.elbow(e) \wedge agent(e)=y_1 \wedge cause(e')=y_1 \wedge means(e',e) \wedge\\ \quad traversal(e') \wedge theme(e')=y \wedge path(e')=z \wedge through(z,\iota x.[crowd(x)]) :\\ p \multimap a\end{array}}$$

$$\dfrac{[x_1 : p]^2 \qquad \begin{array}{l}\lambda y.\exists e.\exists e'.\exists z.elbow(e) \wedge agent(e)=y_1 \wedge cause(e')=y_1 \wedge means(e',e) \wedge\\ \quad traversal(e') \wedge theme(e')=y \wedge path(e')=z \wedge through(z,\iota x.[crowd(x)]) :\\ p \multimap a\end{array}}{\begin{array}{l}\exists e.\exists e'.\exists z.elbow(e) \wedge agent(e)=y_1 \wedge\\ \quad cause(e')=y_1 \wedge means(e',e) \wedge traversal(e') \wedge\\ \quad theme(e')=x_1 \wedge path(e')=z \wedge through(z,\iota x.[crowd(x)]) : a\end{array}}$$

$$\dfrac{\begin{array}{l}\textbf{Sarah}\\ sarah :\\ s\end{array} \qquad \begin{array}{l}\textbf{sig}\\ \lambda y.y \times y :\\ s \multimap s \otimes p\end{array}}{sarah \times sarah : s \otimes p}$$

$$\dfrac{sarah \times sarah : s \otimes p \qquad \begin{array}{l}\exists e.\exists e'.\exists z.elbow(e) \wedge agent(e)=y_1 \wedge\\ \quad cause(e')=y_1 \wedge means(e',e) \wedge traversal(e') \wedge\\ \quad theme(e')=x_1 \wedge path(e')=z \wedge through(z,\iota x.[crowd(x)]) : a\end{array}}{\begin{array}{l}\exists e.\exists e'.\exists z.elbow(e) \wedge agent(e)=sarah \wedge cause(e')=sarah \wedge means(e',e) \wedge traversal(e') \wedge\\ \quad theme(e')=sarah \wedge path(e')=z \wedge through(z,\iota x.[crowd(x)]) : a\end{array}}\ \otimes_{\mathcal{E},1,2}$$

Figure 1: Glue proof for (62), Swedish Directed Motion Construction

$$\dfrac{\dfrac{\textbf{elbowed}}{\lambda e.elbow(e) : rel} \qquad \dfrac{\textsc{Transition}}{\lambda R \lambda x \lambda e \lambda e'.R(e) \wedge agent(e) = x \wedge cause(e') = x : rel \multimap s \multimap e1 \multimap e2 \multimap a}}{\lambda x \lambda e \lambda e'.elbow(e) \wedge agent(e) = x \wedge cause(e') = x : s \multimap e1 \multimap e2 \multimap a}$$

$$\dfrac{[y_1 : s]^1 \qquad \lambda x \lambda e \lambda e'.elbow(e) \wedge agent(e) = x \wedge cause(e') = x : s \multimap e1 \multimap e2 \multimap a}{\lambda e \lambda e'.elbow(e) \wedge agent(e) = y_1 \wedge cause(e') = y_1 : e1 \multimap e2 \multimap a}$$

$$\dfrac{\lambda e \lambda e'.elbow(e) \wedge agent(e) = y_1 \wedge cause(e') = y_1 : e1 \multimap e2 \multimap a \qquad \dfrac{\textsc{Means}}{\lambda P \lambda e \lambda e'.P(e)(e') \wedge means(e', e) : (e1 \multimap e2 \multimap a) \multimap (e1 \multimap e2 \multimap a)}}{\lambda e \lambda e'.elbow(e) \wedge agent(e) = y_1 \wedge cause(e') = y_1 \wedge means(e', e) : e1 \multimap e2 \multimap a}$$

$$\dfrac{[e'' : e1]^3 \qquad \lambda e \lambda e'.elbow(e) \wedge agent(e) = y_1 \wedge cause(e') = y_1 \wedge means(e', e) : e1 \multimap e2 \multimap a}{\lambda e'.elbow(e'') \wedge agent(e'') = y_1 \wedge cause(e') = y_1 \wedge means(e', e'') : e2 \multimap a}$$

$$\dfrac{\lambda e'.elbow(e'') \wedge agent(e'') = y_1 \wedge cause(e') = y_1 \wedge means(e', e'') : e2 \multimap a \qquad \dfrac{\textsc{Traversal}}{\lambda P \lambda e'.P(e') \wedge traversal(e') : (e2 \multimap a) \multimap (e2 \multimap a)}}{\lambda e'.elbow(e'') \wedge agent(e'') = y_1 \wedge cause(e') = y_1 \wedge means(e', e'') \wedge traversal(e') : e2 \multimap a}$$

$$\dfrac{\lambda e'.elbow(e'') \wedge agent(e'') = y_1 \wedge cause(e') = y_1 \wedge means(e', e'') \wedge traversal(e') : e2 \multimap a}{\lambda e'' \lambda e'.elbow(e'') \wedge agent(e'') = y_1 \wedge cause(e') = y_1 \wedge means(e', e'') \wedge traversal(e') : e1 \multimap e2 \multimap a} \multimap_{\mathcal{I},3}$$

$$\dfrac{[z : p]^4 \qquad \dfrac{\textbf{her}_2}{\lambda x \lambda P \iota y.[P(y) \wedge R_c(x, y)] : p \multimap (v \multimap r) \multimap w}}{\lambda P \iota y.[P(y) \wedge R_c(z, y)] : (v \multimap r) \multimap w}$$

$$\dfrac{\lambda P \iota y.[P(y) \wedge R_c(z, y)] : (v \multimap r) \multimap w \qquad \dfrac{\textbf{way}}{\lambda x.way(x) : v \multimap r}}{\dfrac{\iota y.[way(y) \wedge R_c(z, y)] : w}{\lambda z.\iota y.[way(y) \wedge R_c(z, y)] : p \multimap w} \multimap_{\mathcal{I},4}}$$

$$\dfrac{\dfrac{\textsc{English-Way}}{\lambda Y \lambda Q \lambda P \lambda x.\exists e.\exists e'.\exists z.P(e)(e') \wedge theme(e') = x \wedge path(e') = z \wedge Q(z) \wedge z = Y(x) : (p \multimap w) \multimap (pa \multimap t) \multimap (e1 \multimap e2 \multimap a) \multimap p \multimap a} \qquad \lambda z.\iota y.[way(y) \wedge R_c(z, y)] : p \multimap w}{\lambda Q \lambda P \lambda x.\exists e.\exists e'.\exists z.P(e)(e') \wedge theme(e') = x \wedge path(e') = z \wedge Q(z) \wedge z = \iota y.[way(y) \wedge R_c(x, y)] : (pa \multimap t) \multimap (e1 \multimap e2 \multimap a) \multimap p \multimap a}$$

$$\dfrac{\dfrac{\textbf{through}}{\lambda z \lambda y.through(y, z) : c \multimap pa \multimap t} \qquad \dfrac{\textbf{the crowd}}{\iota x.[crowd(x)] : c}}{\lambda y.through(y, \iota x.[crowd(x)]) : pa \multimap t}$$

$$\dfrac{\lambda Q \lambda P \lambda x.\exists e.\exists e'.\exists z.P(e)(e') \wedge theme(e') = x \wedge path(e') = z \wedge Q(z) \wedge z = \iota y.[way(y) \wedge R_c(x, y)] : (pa \multimap t) \multimap (e1 \multimap e2 \multimap a) \multimap p \multimap a \qquad \lambda y.through(y, \iota x.[crowd(x)]) : pa \multimap t}{\lambda P \lambda x.\exists e.\exists e'.\exists z.P(e)(e') \wedge theme(e') = x \wedge path(e') = z \wedge through(z, \iota x.[crowd(x)]) \wedge z = \iota y.[way(y) \wedge R_c(x, y)] : (e1 \multimap e2 \multimap a) \multimap p \multimap a}$$

$$\dfrac{\lambda e'' \lambda e'.elbow(e'') \wedge agent(e'') = y_1 \wedge cause(e') = y_1 \wedge means(e', e'') \wedge traversal(e') : e1 \multimap e2 \multimap a \qquad \lambda P \lambda x.\exists e.\exists e'.\exists z.P(e)(e') \wedge theme(e') = x \wedge path(e') = z \wedge through(z, \iota x.[crowd(x)]) \wedge z = \iota y.[way(y) \wedge R_c(x, y)] : (e1 \multimap e2 \multimap a) \multimap p \multimap a}{\lambda x.\exists e.\exists e'.\exists z.elbow(e) \wedge agent(e) = y_1 \wedge cause(e') = y_1 \wedge means(e', e) \wedge traversal(e') \wedge theme(e') = x \wedge path(e') = z \wedge through(z, \iota x.[crowd(x)]) \wedge z = \iota y.[way(y) \wedge R_c(x, y)] : p \multimap a}$$

$$\dfrac{[x_1 : p]^2 \qquad \lambda x.\exists e.\exists e'.\exists z.elbow(e) \wedge agent(e) = y_1 \wedge cause(e') = y_1 \wedge means(e', e) \wedge traversal(e') \wedge theme(e') = x \wedge path(e') = z \wedge through(z, \iota x.[crowd(x)]) \wedge z = \iota y.[way(y) \wedge R_c(x, y)] : p \multimap a}{\exists e.\exists e'.\exists z.elbow(e) \wedge agent(e) = y_1 \wedge cause(e') = y_1 \wedge means(e', e) \wedge traversal(e') \wedge theme(e') = x_1 \wedge path(e') = z \wedge through(z, \iota x.[crowd(x)]) \wedge z = \iota y.[way(y) \wedge R_c(x_1, y)] : a}$$

$$\dfrac{\dfrac{\textbf{Sarah}}{sarah : s} \qquad \dfrac{\textbf{her}_1}{\lambda y.y \times y : s \multimap s \otimes p}}{sarah \times sarah : s \otimes p}$$

$$\dfrac{sarah \times sarah : s \otimes p \qquad \exists e.\exists e'.\exists z.elbow(e) \wedge agent(e) = y_1 \wedge cause(e') = y_1 \wedge means(e', e) \wedge traversal(e') \wedge theme(e') = x_1 \wedge path(e') = z \wedge through(z, \iota x.[crowd(x)]) \wedge z = \iota y.[way(y) \wedge R_c(x_1, y)] : a}{\exists e.\exists e'.\exists z.elbow(e) \wedge agent(e) = sarah \wedge cause(e') = sarah \wedge means(e', e) \wedge traversal(e') \wedge theme(e') = sarah \wedge path(e') = z \wedge through(z, \iota x.[crowd(x)]) \wedge z = \iota y.[way(y) \wedge R_c(sarah, y)] : a} \otimes_{\mathcal{E},1,2}$$

Figure 2: Glue proof for (65), English *Way* Construction (means interpretation)

Transition

$$\lambda R \lambda x \lambda e \lambda e'.R(e) \wedge agent(e) = x \wedge cause(e') = x : rel \multimap s \multimap e1 \multimap e2 \multimap a$$

$$[R' : rel]^4$$

$$\lambda x \lambda e \lambda e'.R'(e) \wedge agent(e) = x \wedge cause(e') = x : s \multimap e1 \multimap e2 \multimap a$$

$$[y_1 : s]^1$$

$$\lambda e \lambda e'.R'(e) \wedge agent(e) = y_1 \wedge cause(e') = y_1 : e1 \multimap e2 \multimap a$$

$$[e'' : e1]^3$$

$$\lambda e'.R'(e) \wedge agent(e'') = y_1 \wedge cause(e') = y_1 : e2 \multimap a$$

$$\lambda R'.\lambda e'.R'(e) \wedge agent(e'') = y_1 \wedge cause(e') = y_1 : rel \multimap e2 \multimap a \quad \multimap_{\mathcal{I},4}$$

Manner

$$\lambda P \lambda R \lambda e'.P(R)(e') \wedge manner(e', R) : (rel \multimap e2 \multimap a) \multimap (rel \multimap e2 \multimap a)$$

$$\lambda R \lambda e'.R(e) \wedge agent(e'') = y_1 \wedge cause(e') = y_1 \wedge manner(e', R) : rel \multimap e2 \multimap a$$

elbowed

$$\lambda e.elbow(e) : rel$$

$$\lambda e'.elbow(e'') \wedge agent(e'') = y_1 \wedge cause(e') = y_1 \wedge manner(e', elbow) : e2 \multimap a$$

Traversal

$$\lambda P \lambda e'.P(e') \wedge traversal(e') : (e2 \multimap a) \multimap (e2 \multimap a)$$

$$\lambda e'.elbow(e'') \wedge agent(e'') = y_1 \wedge cause(e') = y_1 \wedge manner(e', elbow) \wedge traversal(e') : e2 \multimap a$$

$$\lambda e'' \lambda e'.elbow(e'') \wedge agent(e'') = y_1 \wedge cause(e') = y_1 \wedge manner(e', elbow) \wedge traversal(e') : e1 \multimap e2 \multimap a \quad \multimap_{\mathcal{I},3}$$

English-Way

$$\lambda Y \lambda Q \lambda P \lambda x.\exists e.\exists e'.\exists z.P(e)(e') \wedge theme(e') = x \wedge path(e') = z \wedge Q(z) \wedge z = Y(x) : (p \multimap w) \multimap (pa \multimap t) \multimap (e1 \multimap e2 \multimap a) \multimap p \multimap a$$

her$_2$

$$\lambda x \lambda P \iota y.[P(y) \wedge R_c(x, y)] : p \multimap (v \multimap r) \multimap w$$

$$[z : p]^5$$

$$\lambda P \iota y.[P(y) \wedge R_c(z, y)] : (v \multimap r) \multimap w$$

way

$$\lambda x.way(x) : v \multimap r$$

$$\iota y.[way(y) \wedge R_c(z, y)] : w$$

$$\lambda z.\iota y.[way(y) \wedge R_c(z, y)] : p \multimap w \quad \multimap_{\mathcal{I},5}$$

$$\lambda Q \lambda P \lambda x.\exists e.\exists e'.\exists z.P(e)(e') \wedge theme(e') = x \wedge path(e') = z \wedge Q(z) \wedge z = \iota y.[way(y) \wedge R_c(x, y)] : (pa \multimap t) \multimap (e1 \multimap e2 \multimap a) \multimap p \multimap a$$

through

$$\lambda z \lambda y.through(y, z) : c \multimap pa \multimap t$$

the crowd

$$\iota x.[crowd(x)] : c$$

$$\lambda y.through(y, \iota x.[crowd(x)]) : pa \multimap t$$

$$\lambda P \lambda x.\exists e.\exists e'.\exists z.P(e)(e') \wedge theme(e') = x \wedge path(e') = z \wedge through(z, \iota x.[crowd(x)]) \wedge z = \iota y.[way(y) \wedge R_c(x, y)] : (e1 \multimap e2 \multimap a) \multimap p \multimap a$$

$$\lambda x.\exists e.\exists e'.\exists z.elbow(e) \wedge agent(e) = y_1 \wedge cause(e') = y_1 \wedge manner(e', elbow) \wedge traversal(e') \wedge theme(e') = x \wedge path(e') = z \wedge through(z, \iota x.[crowd(x)]) \wedge z = \iota y.[way(y) \wedge R_c(x, y)] : p \multimap a$$

$$[x_1 : p]^2$$

$$\exists e.\exists e'.\exists z.elbow(e) \wedge agent(e) = y_1 \wedge cause(e') = y_1 \wedge manner(e', elbow) \wedge traversal(e') \wedge theme(e') = x_1 \wedge path(e') = z \wedge through(z, \iota x.[crowd(x)]) \wedge z = \iota y.[way(y) \wedge R_c(x_1, y)] : a$$

Sarah

$$sarah : s$$

her$_1$

$$\lambda y.y \times y : s \multimap s \otimes p$$

$$sarah \times sarah : s \otimes p$$

$$\exists e.\exists e'.\exists z.elbow(e) \wedge agent(e) = sarah \wedge cause(e') = sarah \wedge manner(e', elbow) \wedge traversal(e') \wedge theme(e') = sarah \wedge path(e') = z \wedge through(z, \iota x.[crowd(x)]) \wedge z = \iota y.[way(y) \wedge R_c(sarah, y)] : a \quad \otimes_{\mathcal{E},1,2}$$

Figure 3: Glue proof for (65), English *Way* Construction (manner interpretation)

(68) Chesterfield negotiated Britain's way into the Treaty of Vienna.

negotiated

$$\lambda e.negotiate(e) : rel$$

Transition

$$\lambda R \lambda x \lambda e \lambda e'.R(e) \wedge agent(e) = x \wedge cause(e') = x : rel \multimap c \multimap e1 \multimap e2 \multimap n$$

$$\lambda x \lambda e \lambda e'.negotiate(e) \wedge agent(e) = x \wedge cause(e') = x : c \multimap e1 \multimap e2 \multimap n$$

Chesterfield

$$chesterfield : c$$

$$\lambda e \lambda e'.negotiate(e) \wedge agent(e) = chesterfield \wedge cause(e') = chesterfield : e1 \multimap e2 \multimap n$$

Means

$$\lambda P \lambda e \lambda e'.P(e)(e') \wedge means(e', e) : (e1 \multimap e2 \multimap n) \multimap (e1 \multimap e2 \multimap n)$$

$$\lambda e \lambda e'.negotiate(e) \wedge agent(e) = chesterfield \wedge cause(e') = chesterfield \wedge means(e', e) : e1 \multimap e2 \multimap n$$

$$[e'' : e1]^1$$

$$\lambda e'.negotiate(e'') \wedge agent(e'') = chesterfield \wedge cause(e') = chesterfield \wedge means(e', e'') : e2 \multimap n$$

Traversal

$$\lambda P \lambda e'.P(e') \wedge traversal(e') : (e2 \multimap n) \multimap (e2 \multimap n)$$

$$\lambda e'.negotiate(e'') \wedge agent(e'') = chesterfield \wedge cause(e') = chesterfield \wedge means(e', e'') \wedge traversal(e') : e2 \multimap n$$

$$\multimap_{\mathcal{I},1}$$

$$\lambda e'' \lambda e'.negotiate(e'') \wedge agent(e'') = chesterfield \wedge cause(e') = chesterfield \wedge means(e', e'') \wedge traversal(e') : e1 \multimap e2 \multimap n$$

English-Way

$$\lambda Y \lambda Q \lambda P \lambda x.\exists e.\exists e'.\exists z.P(e)(e') \wedge theme(e') = x \wedge path(e') = z \wedge Q(z) \wedge z = Y(x) : (b \multimap w) \multimap (pa \multimap i) \multimap (e1 \multimap e2 \multimap a) \multimap b \multimap n$$

's

$$\lambda x \lambda P \iota y.[P(y) \wedge R_c(x, y)] : b \multimap (v \multimap r) \multimap w$$

$$[z : b]^2$$

$$\lambda P \iota y.[P(y) \wedge R_c(z, y)] : (v \multimap r) \multimap w$$

way

$$\lambda x.way(x) : v \multimap r$$

$$\iota y.[way(y) \wedge R_c(z, y)] : w$$

$$\multimap_{\mathcal{I},2}$$

$$\lambda z.\iota y.[way(y) \wedge R_c(z, y)] : b \multimap w$$

$$\lambda Q \lambda P \lambda x.\exists e.\exists e'.\exists z.P(e)(e') \wedge theme(e') = x \wedge path(e') = z \wedge Q(z) \wedge z = \iota y.[way(y) \wedge R_c(x, y)] : (pa \multimap i) \multimap (e1 \multimap e2 \multimap n) \multimap b \multimap n$$

into

$$\lambda z \lambda y.into(y, z) : t \multimap pa \multimap i$$

the Treaty of Vienna

$$t\text{-}o\text{-}v : t$$

$$\lambda y.into(y, t\text{-}o\text{-}v) : pa \multimap i$$

$$\lambda P \lambda x.\exists e.\exists e'.\exists z.P(e)(e') \wedge theme(e') = x \wedge path(e') = z \wedge into(z, t\text{-}o\text{-}v) \wedge z = \iota y.[way(y) \wedge R_c(x, y)] : (e1 \multimap e2 \multimap n) \multimap b \multimap n$$

$$\lambda x.\exists e.\exists e'.\exists z.negotiate(e) \wedge agent(e) = chesterfield \wedge cause(e') = chesterfield \wedge means(e', e) \wedge traversal(e') \wedge theme(e') = x \wedge path(e') = z \wedge into(z, t\text{-}o\text{-}v) \wedge z = \iota y.[way(y) \wedge R_c(x, y)] : b \multimap n$$

Britain

$$britain : b$$

$$\exists e.\exists e'.\exists z.negotiate(e) \wedge agent(e) = chesterfield \wedge cause(e') = chesterfield \wedge means(e', e) \wedge traversal(e') \wedge theme(e') = britain \wedge path(e') = z \wedge into(z, t\text{-}o\text{-}v) \wedge z = \iota y.[way(y) \wedge R_c(britain, y)] : n$$

Figure 4: Glue proof for (68), English *Way* Construction (means interpretation)